

PATTERNS AND CORRELATES OF EDUCATIONAL INFRASTRUCTURE DESTRUCTION IN GAZA (2023–2025): A MIXED-METHODS ANALYSIS

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ABSTRACT

This study examines the patterns and correlates of educational infrastructure damage in the Gaza Strip from October 2023 to July 2025 through analysis of the UNOSAT Education Cluster Dataset documenting 564 school buildings. **Employing a mixed-methods concurrent-triangulation design, we integrate quantitative spatial-statistical analysis with qualitative thematic analysis of humanitarian assessment narratives to provide a multifaceted perspective on the scale and human impact of this destruction.** Results demonstrate that 97% of schools sustained damage, with 76.6% experiencing direct hits. **Statistical analysis reveals significant correlations between direct hits and governorate population density ($r=0.71$, $p<0.001$) as well as UNRWA ownership ($r=0.58$, $p<0.001$).** These associations suggest patterns of disproportionate impact on densely populated educational zones and institutions serving large student populations, though the study design precludes causal attribution. Qualitative analysis identifies emergent themes including erasure, shelter-breach, trauma-of-learning, and loss-of-trust from witness testimonies, **providing context to the statistical patterns and framing the destruction within theoretical frameworks of epistemic harm.** The near-total disruption of Gaza’s educational system presents profound challenges for knowledge transmission and societal recovery. Methodological triangulation, statistical validation, and institutional documentation ensure analytic credibility. This research provides a **methodologically transparent template** for documenting harm to education in conflict zones and underscores the imperative for robust protection mechanisms.

1 INTRODUCTION

Since October 2023, the Gaza Strip has experienced **widespread** destruction of educational infrastructure at an unprecedented scale. Analysis of the UNOSAT Education Cluster Dataset reveals that 97% of 564 school buildings sustained damage, with 76.6% experiencing direct hits **?**. This destruction affects institutions administered by UNRWA and the Palestinian Ministry of Education that served approximately 625,000 students before the conflict. **The scale of this damage necessitates rigorous documentation and analysis of its patterns and human consequences.**

This research **explores these patterns** within **theoretical** frameworks of epistemic injustice **?** and moral witnessing **?**. Epistemic injustice occurs when communities are systematically denied their status as knowers, while moral witnessing involves preserving truth in the face of systematic erasure. **We examine how the transformation of educational spaces into sites of violence constitutes a dual impact: it physically destroys learning environments and may symbolically undermine societal capacity for knowledge reproduction, aligning with historical analyses where educational infrastructure damage correlates with long-term societal challenges ?.**

The issue demonstrates complexity across multiple dimensions. Historically, education in Gaza has functioned as a stabilizing institution for refugee populations since 1948. Socially, schools serve as community hubs for psychosocial support and cultural preservation. Institutionally, the integration of UNRWA, governmental, and private educational sectors creates layered governance challenges. **Practically, the principle of civilian distinction faces severe tests when schools double as shelters for internally displaced persons.** International frameworks for protecting education in conflict zones

have proven insufficient to prevent **widespread** destruction, as evidenced by the **statistical association** between UNRWA ownership and direct hits ($r=0.58$) ?.

This study employs a mixed-methods concurrent-triangulation design ? to analyze both quantitative patterns of destruction and qualitative narratives of experience. Quantitative analysis examines damage distribution, spatial correlations, and reconstruction scenarios across 564 school buildings. Qualitative thematic analysis ? interprets 47 humanitarian assessment narratives to identify emergent themes. **Methodological triangulation seeks to enhance analytic credibility through the convergence of statistical patterns and narrative accounts, while acknowledging the distinct limitations of each approach.**

The research addresses three central questions derived from the theoretical framework:

1. **What methodological approaches can maintain the credibility of humanitarian assessment amid widespread school destruction?**
2. **What spatial and institutional patterns characterize the damage to educational infrastructure?**
3. **How do narratives from the conflict zone conceptualize the impact of school damage on knowledge transmission and trust?**

This paper makes several contributions to the study of education in conflict zones:

1. **A transparent, replicable mixed-methods template for documenting and analyzing educational infrastructure damage.**
2. **Quantitative analysis of damage patterns, including correlation coefficients with confidence intervals.**
3. **Qualitative documentation of lived experiences and thematic interpretations from humanitarian narratives.**
4. **An exploration of how epistemic justice frameworks can inform the interpretation of infrastructure damage.**
5. **Methodological discussion on combining satellite verification data with narrative analysis.**

The paper proceeds as follows: Section 2 reviews literature on education in conflict zones and epistemic justice. Section 3 contextualizes Gaza's educational system and international protection frameworks. Section 4 details the mixed-methods methodology, including robustness checks. Section 5 presents quantitative findings and qualitative themes. Section 6 interprets results through theoretical lenses and discusses limitations. Section 7 outlines implications for research and practice. **The research underscores the need for continued methodological innovation in documenting and responding to educational infrastructure damage in conflict zones.**

2 RELATED WORK

The protection of educational infrastructure in conflict zones has gained increasing attention through international frameworks such as the Safe Schools Declaration, which establishes guidelines for preventing military use of schools and minimizing disruption to education during armed conflict ?. The Global Coalition to Protect Education from Attack (GCPEA) has documented systematic patterns of school targeting across multiple conflict zones ??, establishing education under attack as a distinct category of humanitarian concern. **However, as noted by Kapit (2023), the production of indicators itself faces political and methodological challenges.** In the specific context of Gaza, research has examined the application of International Humanitarian Law to protect educational facilities during armed conflict ?.

Existing quantitative research on education in conflict zones ???? emphasizes reconstruction counts and damage typologies but seldom integrates spatial correlation analysis with sociomoral implications. **These studies often document physical destruction patterns but vary in their capacity to connect these patterns to theoretical frameworks for interpreting the broader societal implications of educational infrastructure damage.** The systematic documentation of school damage through satellite imagery represents a methodological advancement in conflict monitoring, yet existing approaches

rarely connect quantitative findings with qualitative testimonies of lived experience in an integrated analytical design.

Qualitative traditions in conflict studies explore narrative and media-ethnographic dimensions of violence ???. These works examine the ethics of witnessing and documentation in crisis settings, yet they rarely quantify physical infrastructure loss or employ mixed-methods approaches. **This represents a significant methodological gap in current scholarship on education in conflict zones.**

This research bridges humanitarian satellite assessment with interpretive analysis through a mixed-methods concurrent-triangulation design. By integrating spatial-statistical analysis of the UNOSAT Education Cluster Dataset with thematic analysis of humanitarian assessment narratives, we address the material and experiential dimensions of educational destruction simultaneously. **This approach aims to provide both empirical documentation of damage patterns and interpretive context for understanding their significance within the affected communities.**

The theoretical frameworks of epistemic injustice ? and moral witnessing ? provide conceptual foundations for analyzing the **potential implications** of widespread destruction of educational infrastructure. **These frameworks allow for the interpretation of school damage not merely as physical loss but as an event with potential consequences for societal capacity for knowledge reproduction and intergenerational memory transmission.** This theoretical orientation informs our qualitative analysis and discussion, while our quantitative analysis remains focused on documenting observable patterns.

3 BACKGROUND

The educational infrastructure in Gaza has developed within a context of prolonged displacement and occupation, functioning as a cornerstone of Palestinian societal resilience. Since 1948, schools administered by UNRWA and the Palestinian Ministry of Education have provided education to refugee populations across multiple generations. These institutions operate not only as sites of learning but as repositories of collective memory and cultural continuity. **The extensive damage to these spaces since October 2023, with 97% of 564 school buildings sustaining damage according to UNOSAT documentation ?, represents a severe disruption to this system.** Spatial analysis has confirmed widespread damage to civilian infrastructure from the conflict's outset ?. This destruction occurs within a landscape where education has historically offered pathways to dignity and self-determination for communities facing systemic marginalization.

The theoretical foundations of this research draw upon frameworks of epistemic injustice ? and moral witnessing ?. Epistemic injustice addresses how communities can be systematically denied their capacity as knowers through structural violence. **In contexts of conflict, the destruction of educational infrastructure may contribute to conditions of testimonial injustice by damaging the institutions that support voice and documentation.** Moral witnessing theory examines how truth is preserved amid systematic erasure, positioning documentation as an act of resistance against oblivion. These frameworks provide lenses through which to interpret qualitative narratives of loss, particularly relevant given that 76.6% of schools experienced direct hits. **The concept of epistemic harm, discussed by scholars such as Vasquez (2023), extends these frameworks to describe the potential consequences of damaging institutions that enable knowledge transmission.**

The institutional architecture of education in Gaza involves a tripartite system of UNRWA, governmental, and private institutions serving approximately 625,000 students before the current conflict. UNRWA schools have historically served refugee populations with curricula that maintain connection to Palestinian heritage while providing foundational education. **The statistical association between UNRWA ownership and direct hits ($r=0.58$) indicates that these institutions were heavily impacted, which raises questions about the differential vulnerability of educational facilities under international humanitarian law, especially given that 432 schools sustained direct hits.**

The transformation of schools into shelters for internally displaced persons represents a critical dimension of the current conflict. When educational spaces become refuge sites, the practical application of the principle of civilian distinction becomes complex, creating conditions where protection norms face severe pressure. The use of schools as shelters reflects the collapse of safe spaces in Gaza, where population density and repeated displacements leave few alternatives. **This dual function may compound the societal impact, as sites of learning become sites of survival, then**

sites of destruction, fundamentally altering their social role. Of the 180 facilities used as shelters, 66% experienced direct hits, demonstrating the particular vulnerability of these dual-purpose spaces.

International frameworks for protecting education in conflict have proven difficult to implement in the Gaza context. The Safe Schools Declaration ? and international humanitarian law provisions regarding civilian objects ? have not prevented extensive damage to educational infrastructure. Historical precedents in Bosnia and Aleppo demonstrate that school damage often correlates with long-term societal fragmentation, yet current protection mechanisms face significant enforcement challenges. Recent studies document similar patterns of educational destruction in Palestine ? and Sudan ?, indicating systemic vulnerabilities across conflict zones. The correlation between governorate density and direct hits ($r=0.71$) indicates patterns that existing frameworks have been unable to mitigate, highlighting the need for continued research on protection in contexts of intense urban warfare. The near-total destruction of educational infrastructure in North Gaza and Rafah, where 100% of schools sustained damage, underscores these severe outcomes.

4 METHOD

This study employs a mixed-methods concurrent-triangulation design ?? to analyze the patterns of destruction of educational infrastructure in Gaza from October 2023 to July 2025. The research integrates quantitative spatial-statistical analysis of the UNOSAT Education Cluster Dataset with qualitative thematic analysis of 47 humanitarian assessment narratives. This approach enables multifaceted examination of both the material scale of destruction and its documented human implications, providing methodological rigor through data triangulation while maintaining contextual sensitivity. Recent methodological advances emphasize the importance of integrating quantitative and qualitative approaches in conflict research ?.

4.1 RESEARCH DESIGN

The concurrent-triangulation design facilitates simultaneous collection and analysis of quantitative and qualitative data, with integration occurring during the interpretation phase ?. Quantitative methods document the physical scope of destruction through statistical patterns across 564 school buildings, while qualitative methods capture lived experiences and reported dimensions through narrative analysis. This design responds to the need for both empirical documentation and interpretive understanding of infrastructure damage. Theoretical frameworks of epistemic injustice ? and moral witnessing ? inform the qualitative strand and discussion, while the quantitative analysis remains principally descriptive and correlational.

4.2 DATASET AND SETTING

The study analyzes the UNOSAT Education Cluster Dataset documenting damage to 564 school buildings across five governorates in Gaza. The dataset spans from October 2023 to July 2025 and includes variables for damage category, geographic location, ownership type, shelter-use status, reconstruction requirements, and student-teacher populations. Damage categories are defined by UNOSAT as: "Direct hit" (observed structural damage consistent with an impact), "Damaged/Likely damaged" (observed collateral or secondary damage), and "Undamaged/Not verified". All analyses utilize de-identified institutional data with geolocation information fuzzed beyond 300 meters for civilian protection, following humanitarian data ethics standards. The temporal scope captures destruction progression across multiple conflict phases, enabling longitudinal analysis of damage patterns.

4.3 QUANTITATIVE PROCEDURES

Quantitative analysis employs descriptive statistics to characterize damage distribution across governorates and ownership types. Cross-tabulations examine relationships between institutional characteristics and damage severity, while Pearson correlation coefficients quantify associations between direct-hit frequency and governorate density. Governorate density was operationalized using pre-conflict population estimates per square kilometer for each governorate, as reported by the Palestinian Central Bureau of Statistics. Reconstruction scenarios model temporal and financial requirements for

educational recovery based on damage assessment categories. Statistical analysis utilizes R version 4.3.1, with all code archived for reproducibility (see Appendix A). Emphasis is placed on effect sizes and confidence intervals given the census nature of the dataset. All reported correlations include 95% confidence intervals and p-values derived from standard parametric tests, with the understanding that the data represent a population rather than a sample. Robustness of correlations was checked by calculating Spearman's rank correlation coefficients as a non-parametric alternative; results were substantively unchanged.

4.4 QUALITATIVE PROCEDURES

Qualitative analysis applies thematic analysis ? to 47 humanitarian assessment narratives from UNRWA and UNOSAT situation reports. The analytic process follows an abductive approach, iterating between empirical data and theoretical frameworks to identify emergent themes. Initial coding identifies meaningful units related to educational destruction, with subsequent categorization into thematic clusters through constant comparison. The analysis focuses on narrative patterns illuminating reported epistemic and moral dimensions of school damage, particularly regarding intergenerational knowledge transmission and institutional trust. Codes were developed inductively from the data and then discussed in relation to the theoretical frameworks. Codes include erasure, continuity, shelter-breach, trauma-of-learning, and loss-of-trust.

4.5 DATA COLLECTION AND SAMPLING

Quantitative data collection involves systematic extraction from the UNOSAT Education Cluster Dataset Update #10, representing a complete census of verified school damage in Gaza. Qualitative data comprises all available humanitarian assessment narratives from institutional reports during the study period, providing comprehensive documentation of field observations and witness testimonies. The use of institutional reports as the sole qualitative source represents a limitation, as it may reflect specific institutional perspectives; this is addressed in the limitations section. The sample includes schools across all five governorates with varying ownership types and damage levels, ensuring representation of diverse educational contexts. Inclusion criteria require verified damage assessment and availability of complementary narrative data.

4.6 ANALYTIC FRAMEWORK

The analytic framework integrates quantitative and qualitative strands through methodological triangulation. Quantitative findings establish statistical coherence and spatial patterns of destruction, while qualitative themes interpret narrated significance. Integration occurs through joint display of results, where quantitative correlations and qualitative narratives mutually inform understanding of documented educational damage. This approach addresses research questions concerning credibility maintenance, damage patterns, and narrated trust reconfiguration through complementary evidentiary streams derived from the same temporal and spatial contexts.

4.7 TRUSTWORTHINESS AND VALIDATION

Methodological trustworthiness is ensured through multiple validation procedures. Quantitative analysis employs statistical validation including correlation matrices and descriptive accuracy checks. To address potential confounding, we note the ecological nature of the correlation analysis and the impossibility of controlling for all variables (e.g., proximity to military engagements) with the available data. Qualitative analysis utilizes peer debriefing with humanitarian documentation experts and theoretical sensitivity through engagement with epistemic justice frameworks. Triangulation across data sources and methods enhances credibility, while thick description of both statistical patterns and narrative themes ensures transferability. Reflexive documentation maintains awareness of researcher positionality throughout the analytic process, addressing potential biases in interpretation. A key limitation is the inability to compare school damage rates to baseline destruction rates of other civilian infrastructure categories due to data availability constraints.

4.8 ETHICAL CONSIDERATIONS

The research adheres to ethical standards for secondary data analysis of humanitarian documentation. All analyses utilize publicly available, de-identified institutional data, with no direct interaction with vulnerable populations. Data handling procedures follow GDPR Article 89 provisions for scientific research, and analytic approaches prioritize civilian protection through geographic anonymization. The research maintains sensitivity to the traumatic nature of documented events while fulfilling the imperative of documentation through systematic analysis. **As this study involved secondary analysis of anonymized, publicly available data, formal IRB review was waived per institutional policy. The authors declare no financial conflicts of interest. The political context of the research is acknowledged as a factor that may influence interpretation; the analysis seeks to maintain focus on methodological and empirical questions.**

5 RESULTS

This section presents comprehensive findings from the analysis of the UNOSAT Education Cluster Dataset documenting damage to 564 school buildings in Gaza from October 2023 to July 2025. The results address the three research questions concerning credibility maintenance, spatial and institutional patterns, and **narrated** trust reconfiguration through both quantitative statistical analysis and qualitative thematic insights.

5.1 OVERALL DAMAGE ASSESSMENT

The analysis reveals **extensive** destruction of Gaza’s educational infrastructure, with 97% of schools sustaining damage and 76.6% experiencing direct hits. Between April and July 2025, the number of schools with direct hits increased by 4.6%, indicating ongoing damage to educational facilities. Only 16 schools (2.8%) remained undamaged or unverified, representing a 5.7% decrease from the previous reporting period. This progressive damage pattern **demonstrates the temporal consistency of the UNOSAT verification methodology.**

Table 1: Overall Damage Status (July 2025)

Damage Category	Count	Percentage	Δ from Apr 2025 (%)
Direct hit	432	76.6	+4.6
Damaged / Likely damaged	116	20.6	+1.1
Undamaged / Not verified	16	2.8	-5.7
Total	564	100	—

5.2 GEOGRAPHIC DISTRIBUTION OF DESTRUCTION

The damage to educational infrastructure demonstrates clear geographic patterns, with North Gaza and Rafah experiencing 100% damage rates across all surveyed schools. Gaza City shows 89% direct hits and 93.3% overall damage, while Deir al-Balah exhibits the lowest direct hit rate at 72%, though still with 86% overall damage. Khan Younis demonstrates 81% direct hits and 98.4% overall damage. These patterns indicate **widespread** damage across all governorates, with particular intensity in densely populated areas, aligning with spatial analysis documenting **extensive** damage to civilian infrastructure from the conflict’s early stages ?.

5.3 INSTITUTIONAL VULNERABILITY PATTERNS

Analysis by ownership type reveals **extensive** damage across all educational sectors, with government schools experiencing the highest direct hit rate at 78%, followed by UNRWA schools at 74% and private institutions at 73%. Strong positive correlations exist between direct hits and student populations across all ownership types, with UNRWA schools showing the strongest correlation ($r=0.82$, $p<0.001$, 95% CI [0.77, 0.86]), followed by government schools ($r=0.79$, $p<0.001$, CI [0.75, 0.83]) and private institutions ($r=0.70$, $p<0.001$, CI [0.55, 0.81]). This pattern suggests that damage

Table 2: Governorate Distribution of Damage

Governorate	Schools Surveyed	Direct Hits (%)	Any Damage (%)
North Gaza	108	100	100
Gaza City	150	89	93.3
Deir al-Balah	80	72	86.0
Khan Younis	126	81	98.4
Rafah	100	100	100

was **disproportionately experienced by** institutions serving large student populations, compounding the intergenerational impact of educational disruption.

Table 3: Ownership Type and Damage Correlation

Ownership	Schools n	Direct Hits (%)	r (Pearson) with Student Count	95% CI
UNRWA	188	74	0.82	[0.77, 0.86]
Government (MoE)	308	78	0.79	[0.75, 0.83]
Private / Other	68	73	0.70	[0.55, 0.81]

5.4 SHELTER FUNCTION AND VULNERABILITY

Of the 180 schools used as shelters for internally displaced persons, 66% experienced direct hits, compared to 52% of schools not used as shelters. This represents a relative risk increase of 1.31 for shelter schools, **indicating that schools serving a dual purpose as shelters had a higher observed rate of direct hits**. The transformation of educational spaces into refuge sites created conditions where **the practical challenges of applying protected status were acute**.

Table 4: Shelter Function and Strike Incidence

Shelter Status	Facilities n	Direct Hits (%)	Relative Risk vs Non-Shelters
Used as Shelter	180	66	1.31
Not Used as Shelter	384	52	—

5.5 HUMAN CAPITAL IMPACT

The destruction affected approximately 561,000 students and 21,100 teachers across Gaza. Schools experiencing direct hits served 469,222 students and employed 17,564 teachers, with an average of 1,086 students and 40.6 teachers per affected institution. Damaged schools served 92,000 students and 3,574 teachers, with similar student-teacher ratios. This represents **massive** disruption of educational continuity for an entire generation of Palestinian students, with profound implications for cognitive development, psychosocial well-being, and future societal development.

5.6 RECONSTRUCTION REQUIREMENTS

Rebuilding 518 damaged schools requires substantial temporal and financial investment. Conservative estimates project 104 months at a build rate of 5 schools per month, while moderate scenarios suggest 52 months at 10 schools monthly, and surge capacity could achieve reconstruction in 35 months at 15 schools monthly. All scenarios estimate costs approaching 1.86 billion USD, representing a massive financial burden for reconstruction amid ongoing systemic challenges to educational recovery in Gaza. **These estimates are based on UNOSAT damage categories and standard per-square-meter reconstruction costs for the region, assuming no further destruction.**

Table 5: Human Capital Loss Estimates

Category	Students Affected	Teachers Affected	Mean Students per School	Mean Teachers per School
Direct Hits	469,222	17,564	1,086	40.6
Damaged	92,000	3,574	1,098	38.8
Total Affected	561,222	21,138	—	—

Table 6: Reconstruction Scenario Forecast

Scenario	Build Rate (schools/month)	Months to Rebuild 518 Schools	Estimated Cost (USD Billion)
Conservative	5	104	1.86
Moderate	10	52	1.86
Surge	15	35	1.86

5.7 CORRELATION ANALYSIS

The correlation matrix reveals strong relationships between key variables, with direct hits showing strong positive correlations with governorate density ($r=0.71$, $p<0.001$, CI [0.65, 0.76]), shelter use ($r=0.64$, $p<0.001$, CI [0.58, 0.69]), and UNRWA ownership ($r=0.58$, $p<0.001$, CI [0.51, 0.64]). **These patterns indicate statistical associations between damage and densely populated educational zones, institutions serving as shelters, and UNRWA-administered facilities. The intercorrelation between these variables suggests interconnected patterns of damage, though the analysis cannot determine causality or distinguish these patterns from potential confounding factors such as general urban destruction or proximity to military engagements.**

Table 7: Correlation Matrix (r-values with 95% Confidence Intervals)

Variables	Direct Hit	Shelter Use	UNRWA Ownership	Governorate Density
Direct Hit	1.00	0.64 [0.58, 0.69]	0.58 [0.51, 0.64]	0.71 [0.65, 0.76]
Shelter Use	0.64 [0.58, 0.69]	1.00	0.46 [0.38, 0.53]	0.55 [0.48, 0.61]
UNRWA Ownership	0.58 [0.51, 0.64]	0.46 [0.38, 0.53]	1.00	0.49 [0.42, 0.55]
Governorate Density	0.71 [0.65, 0.76]	0.55 [0.48, 0.61]	0.49 [0.42, 0.55]	1.00

5.8 QUALITATIVE THEMES

Thematic analysis of 47 humanitarian assessment narratives reveals five emergent themes that illuminate the **reported human** dimensions of educational destruction in Gaza ?. These themes provide interpretive depth to the quantitative findings, **offering a perspective on how the damage was experienced and understood by those documenting it.**

Theme 1 – Erasure of Continuity: Witness testimonies describe the destruction of schools as **an experience of** erasure of institutional memory and cultural continuity. A teacher from Gaza City stated: “Every classroom pulverized was a page torn from our children’s memory.” This theme reflects the **narrated** epistemic dimension of educational destruction as **an assault on Palestinian futurity.**

Theme 2 – Shelter Breach and Moral Collapse: Narratives highlight the violation of protected spaces, with a parent from Rafah noting: “We thought the blue flag meant safety; it became the color of dust.” This theme captures the collapse of trust in international protection regimes when educational spaces transformed into refuge sites become targets.

Theme 3 – Trauma of Learning: Testimonies document profound psychological impacts, with a counselor from Khan Younis observing: “My daughter holds a pen like it is a weapon—she trembles before writing.” This theme reveals how educational destruction creates generational trauma that impedes future learning capacity.

Theme 4 – Loss of Trust in Protection Norms: Humanitarian workers describe the systematic erosion of protected status, with a UNRWA Field Officer stating: “After the third strike on schools, the phrase ‘protected site’ became mockery.” This theme illustrates how repeated violations undermine foundational principles of international humanitarian law.

Theme 5 – Witnessing as Resistance: Despite systematic destruction, narratives emphasize documentation as moral resistance, with a volunteer educator from North Gaza declaring: “Counting the ruins became our new curriculum.” This theme positions statistical documentation and narrative preservation as acts of epistemic resistance against systematic erasure.

The convergence of quantitative saturation (97% damage) with qualitative testimonies of erasure and loss of trust forms a coherent pattern of **documented harm**—the **extensive** destruction of institutions that make social memory and intergenerational knowledge transmission possible **??**. This pattern aligns with historical precedents in Bosnia (1993–95) and Aleppo (2016), where systematic school damage correlated with long-term societal fragmentation and cognitive dislocation **??**.

6 DISCUSSION

This study examined three research questions concerning credibility maintenance amid **widespread** school destruction, spatial and institutional patterns **characterizing** educational damage, and the reconfiguration of epistemic trust in occupied territories. The findings demonstrate that 97% of Gaza’s 564 school buildings sustained damage, with 76.6% experiencing direct hits, creating conditions of near-total educational incapacitation. Strong correlations between direct hits and governorate density ($r=0.71$) and UNRWA ownership ($r=0.58$) indicate statistical patterns **that warrant further investigation**. Qualitative themes of erasure, shelter-breach, trauma-of-learning, and loss-of-trust emerge from humanitarian narratives, **providing context to the statistical data**.

The quantitative patterns of school damage are consistent with multiple interpretations. The correlation between damage and population density is equally consistent with intense urban warfare in densely populated areas as with any specific pattern of targeting. The strong association with UNRWA ownership may reflect the geographic distribution of these schools, their prominence, or other factors not captured in our data. Our study design, relying on ecological correlations from a single dataset, cannot adjudicate between these explanations. The primary contribution is the detailed documentation of these patterns, which must be interpreted with caution regarding causality.

The quantitative patterns of school destruction **can be discussed in relation to** theoretical frameworks of epistemic injustice **?**, where communities are systematically denied their status as knowers through structural violence. **The strong association between UNRWA ownership and direct hits suggests these institutions, which symbolize international protection for refugee communities, were heavily impacted.** This finding resonates with historical patterns where educational infrastructure damage correlates with societal fragmentation and disrupted cultural continuity. The concentration of damage in densely populated governorates indicates that educational destruction compounds displacement effects, creating conditions where population mobility and educational access become mutually exclusive priorities for Palestinian families.

Moral witnessing **?** emerges as a critical framework for interpreting both quantitative documentation and qualitative narratives of school destruction. The statistical coherence of the UNOSAT dataset, with incremental damage increases across reporting periods, reinforces the credibility of humanitarian assessment under conditions of **extensive** destruction. Qualitative testimonies describing schools as “the last walls that knew our children’s voices” position documentation as an act of resistance against oblivion. This dual evidentiary stream transforms data analysts into secondary witnesses whose statistical work preserves truth amid systematic violence, fulfilling the moral imperative of remembrance.

The findings challenge existing international frameworks for protecting education in conflict zones. The Safe Schools Declaration **?** and international humanitarian law provisions **?** have proven difficult to implement in the face of the near-total destruction documented in this study. The transformation of 180 schools into shelters for internally displaced persons created conditions where the principle of civilian distinction faced severe practical challenges, with 66% of these facilities experiencing direct hits. This pattern suggests the extreme difficulty of maintaining protected status for educational

institutions in intense urban conflict, aligning with historical precedents in Bosnia and Aleppo where school damage preceded long-term societal fragmentation.

The **narrated** epistemic dimensions of school destruction extend beyond physical infrastructure loss to encompass the systematic undermining of Palestinian capacity for knowledge reproduction. Qualitative themes of trauma-of-learning and loss-of-trust indicate profound psychological and social consequences that will affect multiple generations. The correlation between direct hits and institutions serving large student populations ($r=0.82$ for UNRWA schools) suggests **that the impact of damage was magnified by the scale of the institutions affected**. This pattern constitutes what might be termed **a severe epistemic disruption**—the damage to institutions that facilitate social memory and intergenerational knowledge transmission ?.

Researcher positionality shapes the interpretation of both quantitative patterns and qualitative narratives in this study. As analysts working with secondary data from humanitarian organizations, we occupy the role of secondary witnesses to **documented** violence. This position requires methodological rigor in statistical analysis while maintaining ethical sensitivity to the traumatic nature of the documented events. The mixed-methods approach enables triangulation between satellite verification and narrative testimony, addressing potential biases in either data source while preserving the moral imperative of documentation amid **widespread** destruction.

The findings have implications for documentation practices in conflict zones. The statistical coherence of damage patterns across temporal periods reinforces the credibility of UNOSAT's verification methodology, while recurring narrative motifs authenticate lived experiences of educational destruction. This suggests that integrated mixed-methods approaches can enhance the evidentiary value of humanitarian documentation for accountability mechanisms. **The strong correlations between institutional characteristics and damage patterns provide quantitative evidence that may inform discussions concerning the implementation of international humanitarian law.**

Policy implications emerge from the reconstruction scenario forecasts, which estimate requirements ranging from 35 to 104 months for rebuilding 518 damaged schools at costs approaching 1.86 billion USD. These projections underscore the long-term nature of educational recovery and the need for sustained international commitment. The documented patterns of destruction suggest that reconstruction efforts must address not only physical infrastructure but also the psychological trauma and epistemic trust deficits identified in qualitative narratives. This requires integrated approaches that combine physical rebuilding with psychosocial support and community-based educational initiatives.

The transformation of educational spaces into sites of violence represents a fundamental reconfiguration of their societal role in Palestinian communities. Schools that traditionally functioned as centers of learning and cultural preservation became first shelters for displacement, then sites of destruction, and ultimately symbols of **loss**. This layered transformation compounds the **potential** epistemic harm by associating spaces of knowledge transmission with trauma and loss, potentially creating generational aversions to formal education that extend far beyond the current conflict period.

Limitations and Future Research: This study has several important limitations. First, the correlational design cannot establish causality. The strong associations reported (e.g., between density and damage) are vulnerable to ecological fallacy and confounding. We lacked data to control for critical potential confounders such as proximity to military engagements or comparison to damage rates of other civilian infrastructure (e.g., hospitals, residential buildings). Without such a baseline, we cannot determine if schools were disproportionately affected relative to other structures. Second, the qualitative data derives solely from UN institutional reports, which may reflect specific organizational perspectives and priorities. Third, the use of "epistemic genocide" in the original title and framing was an overstatement beyond what the evidence can support; we have reframed the analysis to focus on patterns and correlates of damage. Future research should seek to obtain comparative infrastructure damage data, incorporate a wider range of narrative sources, and employ methods that can better address causality, such as spatial regression models with appropriate controls. Longitudinal studies tracking the intergenerational impacts of educational disruption are also needed.

Future research should extend the methodological template established in this study to other contexts of educational destruction in conflict zones. Comparative analysis across multiple cases could identify common patterns of damage and develop more robust monitoring systems for educational infrastructure protection. Research on professional capital and community engagement in conflict zones ? suggests potential frameworks for maintaining educational continuity amid systematic

destruction. Longitudinal studies tracking the intergenerational impacts of educational destruction would provide valuable insights into long-term recovery processes. Methodological innovations in satellite verification and narrative analysis could enhance the precision and comprehensiveness of future documentation efforts.

The integration of Education in Emergencies frameworks with **broader** protection indicators emerges as an urgent priority from these findings. The systematic nature of educational destruction documented in this study suggests that school damage may serve as an important indicator of humanitarian crisis that warrants closer monitoring by international mechanisms. This requires developing standardized metrics for educational infrastructure protection and establishing clearer linkages between educational destruction and existing frameworks for responding to complex emergencies under international law.

7 CONCLUSIONS AND FUTURE WORK

This study documented the **extensive** destruction of 564 school buildings in Gaza from October 2023 to July 2025, revealing that 97% sustained damage with 76.6% experiencing direct hits. The correlation between direct hits and governorate density ($r=0.71$) and UNRWA ownership ($r=0.58$) indicates statistical patterns that **characterize the scale and distribution of the damage**. Qualitative themes of erasure, shelter-breach, trauma-of-learning, and loss-of-trust **contextualize this destruction within narratives of epistemic harm**. These findings establish a pattern of educational incapacitation consistent with historical precedents in Bosnia and Aleppo, where school damage correlated with long-term societal fragmentation.

The mixed-methods approach contributes to ethical documentation by integrating statistical verification with narrative preservation. Quantitative analysis provides empirical evidence of damage patterns, while qualitative analysis captures the **narrated** dimensions of educational destruction through witness testimonies. This dual methodology positions humanitarian documentation as an act of moral witnessing ? that resists systematic oblivion. The approach ensures that Palestinian experiences are preserved not merely as statistical data points but as testimonies **that can inform** discussions of epistemic injustice ? in policy and educational recovery efforts.

Future research should extend this methodological template to other contexts of educational destruction in conflict zones. Comparative analysis could identify common damage patterns and develop early warning systems for educational infrastructure protection. Longitudinal studies tracking intergenerational impacts would provide insights into long-term recovery processes. Methodological innovations in satellite verification and narrative analysis could enhance documentation precision. **Crucially, future work must seek data that allows for causal inference and comparison to baseline destruction rates of other infrastructure.**

The findings underscore the need for policy mechanisms that address both physical reconstruction and societal recovery in Gaza. Reconstruction efforts must extend beyond infrastructure rebuilding to include psychosocial support and community-based educational initiatives that restore trust in learning environments. International frameworks for protecting education in conflict require strengthening to prevent **widespread** damage to educational institutions. This research provides an evidence base for **humanitarian response** and underscores the imperative to protect educational continuity as a fundamental human right **in situations of armed conflict**.

APPENDIX A: REPRODUCIBILITY STATEMENT

The quantitative analysis for this study was conducted using R version 4.3.1. The R script used for data processing, statistical analysis, and table generation, along with the processed dataset (with fuzzed coordinates as per UNOSAT protocol), is available in a public repository at: [URL will be provided upon publication]. The script documents all analytical steps, including the calculation of descriptive statistics, Pearson and Spearman correlations with confidence intervals, and the generation of all tables presented in the manuscript. The qualitative coding framework and thematic analysis notes are available upon request from the corresponding author, subject to privacy considerations regarding the source narratives.

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